REMARKS

Reconsideration and allowance of the present application are respectfully requested. Claims 1-9 remain pending in the application. Claims 5-6 have been allowed, and claim 7 has been indicated to contain allowable subject matter. Applicants' independent claim 1, along with dependent claims 2-4 and 8-9 are also allowable.

Applicants note with appreciation the Examiner's indication in the Office Action that claims 5-7 contain allowable subject matter. However, in numbered paragraph 3, page 2 of the Office Action, independent claim 1, along with various dependent claims, is rejected as being unpatentable over U.S. Patent 4,196,442 (Kuniya et al.) in view of newly cited U.S. Patent No. 5,994,097 (Gungor et al.) in combination with U.S. Patent 4,482,912 (Chiba et al.). This rejection is respectfully traversed.

Applicants have disclosed a high-power press pack semiconductor module, such as the Figure 1 module (1). Included with the high-power press pack semiconductor module (1) of the Figure 1 embodiment are an electrically conducting base plate (4); at least one electrically conducting top plate (3); at least one semiconductor chip (2) including semiconductor material, a first main electrode that makes contact with the base plate forming a plane interface and a second main electrode that makes contact with the top plate; and a housing (11, 12, 13) containing the base plate, top plate and semiconductor chip. A material is provided adjacent at least one of the first or second main electrodes that, together with the semiconductor material forms a eutectic alloy or an alloy whose melting point is below that of the semiconductor material.

In the Figure 1 embodiment, at least one of the base plate (4) or top plate (3) is made of metal matrix composite material comprising two-dimensional randomly distributed short cut graphite fibers in the plane of the interface in an Al or Ag matrix, whose coefficient of thermal expansion is close to that of the semiconductor material. The metal matrix composite material contains alloy-forming material.

None of the documents relied upon by the Examiner teach or suggest the claim 1 combination which recites a semiconductor chip having first and second electrodes that contact a base plate and a top plate respectively, wherein the base plate or top plate is an electrically conducting plate which is:

(1) made of metal matrix composite material comprising two-dimensionally randomly distributed short cut graphite fibers in the plane of the interface of an Al or Ag matrix; and

(2) made with a coefficient of thermal expansion close to that of the semiconductor material.

The foregoing features are broadly encompassed by claim 1 which recites a high-power press pack semiconductor module, including, among other features, an electrically conducting base plate and at least one electrically conducting top plate. At least one semiconductor chip includes semiconductor material, a first main electrode that makes contact with the base plate forming a plane interface and a second main electrode that makes contact with the top plate. A housing contains the base plate, top plate and semiconductor chip. A material is provided adjacent at least one of said first or second main electrodes that, together with the semiconductor material forms an eutectic alloy or an alloy whose melting point is below that of the semiconductor material.

Claim 1 recites that at least one of said base plate or top plate is made of metal matrix composite material comprising two-dimensional randomly distributed short cut graphite fibers in the plane of the interface in an Al or Ag matrix, whose coefficient of thermal expansion is close to that of the semiconductor material, said metal matrix composite material containing said alloy-forming material.

None of the three documents relied upon by the Examiner, considered individually or in the combination suggested by the Examiner, teach or suggest Applicants' claim 1 combination of features.

The Kuniya et al. patent discloses that it is desirable that the surface portion of an electrode (presumably an electrode such as supporting electrode 4 of Kuniya et al.'s Figure 2), which is bonded or contacted to a semiconductor substrate, has isotropy as far as possible (e.g., col. 4, lines 14-16 and 53-58 and Fig. 1). The Kuniya et al. patent discloses at col. 4, line 31-39, col. 10, line 10-19 that a random distribution of fibers embedded in a matrix used to produce the supporting electrode leads to bulging or swelling of the composition, rendering a random distribution disadvantageous. Accordingly, the Kuniya et al. patent appears to teach away from the supporting electrodes (4) being made of a metal matrix composite material comprising two-dimensional randomly distributed short cut graphite fibers in the plane of the interface in an Al or Ag matrix.

The newly cited Gungor et al. patent does not overcome the deficiencies of the Kuniya et al. patent. The Examiner refers to the composite substrate carrier 10 of Gungor et al. as suitable for use in the Kuniya device, and on page 3 of the Office Action, the Examiner refers to inclusion of graphite fibers in the carrier 10 of Gungor

et al. However, the carrier 10 of Gungor et al. is not used in conjunction with a semiconductor chip having features as recited in Applicants' claim 1.

The Examiner appears to assert that it would have been obvious to use the carrier 10 of Gungor et al. in the device of Kuniya et al. to serve the function of Applicants' claimed "base plate" and/or "top plate." The Gungor patent discloses use of a metal base composite which includes graphite fiber reinforcement (e.g., col. 3, line 47-48). A form of graphite fiber (e.g., length of fibers, regular versus irregular distribution of fibers, and so forth) is not described. Gungor discloses that carrier 10 is a metal matrix plate which contains copper based inserts 12, which are in contact with a heat generating electronic device 18. The copper based inserts provide a heat transfer path (col. 1, line 64-65). The metal matrix composite plate of the Gungor patent is arranged in the same plane as the copper based inserts, i.e., the plate supports the inserts. Therefore, the metal matrix composite plate of the Gungor patent does not form a eutectic alloy with a semiconductor material as recited in Applicants' claim 1. Gungor does not disclose a semiconductor material in contact with the metal matrix material. The carrier 10 is arranged to the side of the electronic devices 18 and is, for example, a complete transistor (col. 2, line 56 -57), so that no semiconductor material is in contact with the metal matrix composite material.

In addition, the Gungor et al. patent does not disclose or suggest use of a semiconductor chip which includes first and second main electrodes that contact a base plate and a top plate, respectively. As such, there would have been no motivation or suggestion to have modified the devices of the Kuniya et al. and Gungor et al. patents to arrive at Applicants' claim 1 combination.

The Chiba et al. patent does not cure the deficiencies of the Kuniya et al. and Gungor et al. patents. The Chiba et al. patent, discloses first and second matrix-fibered composites (e.g., 100) constructed of a copper matrix 110 and bundles of carbon fibers 130 which are embedded in the copper matrix 110 (col. 3, line 11-18 and col. 6, line 59- col. 7, line 3). Between these two layers a metal layer is arranged (col. 2, line 66-col. 3, line 3). The Chiba et al. patent discloses that a stacked or laminated structure is rigidly integrated by sandwiching a metal layer between the first and second matrix-fiber composites (col. 2, line 4-7, vol. 7, line 22-23).

The Chiba et al. patent discloses an exemplary combination of three layers in Chiba's Fig. 2. In the Chiba et a. patent combination, all three layers are integrated into a semiconductor device. The use of one of these layers, leaving out the metal layer or the second matrix-fiber composites, is neither disclosed nor suggested. Therefore, the Chiba et al. patent would not have taught or suggested a high-power press pack semiconductor module wherein at least one of base plate (4) or top plate (3) is made of metal matrix composite material comprising two-dimensional randomly distributed short cut graphite fibers in the plane of the interface in an Al or Ag matrix, whose coefficient of thermal expansion is close to that of the semiconductor material, said metal matrix composite material containing said alloy-forming material, as recited in claim 1.

Thus, none of the three patents cited by the Examiner, considered individually or in the combination relied upon by the Examiner, teach or suggest Applicants' claim 1 combination. Applicants have discovered certain advantages in using randomly distributed graphic fibers such as those recited in claim 1. For example,

the content of graphite fiber can be easily changed, whereas when using a knitted cloth there are only limited possibilities to change the content. Furthermore, by using a knitted cloth, the thermal extension coefficient is influenced only in lateral direction, whereas with randomly distributed fibers the coefficient can also be adapted in a direction perpendicular to the surface of the chip. As the semiconductor module is a press-pack module, no bow from manufacturing or processing condition arises (see page 5 of the description, last sentence of par. 2). The applied references, even if considered in combination as suggested by the Examiner, would not have rendered obvious the recited claim features encompassing these advantages.

For the foregoing reasons, Applicants' claim 1 is allowable. The remaining claims depend from claim 1 and recite additional advantageous features which further distinguish over the documents relied upon by the Examiner. As such, the present application is in condition for allowance.

All objections and rejections raised in the Office Action having been addressed, it is respectfully submitted that the application is in condition for allowance and a Notice of Allowance is respectfully solicited.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

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By: _____
Patrick C. Keane
Registration No. 32,828

P.O. Box 1404
Alexandria, VA 22313-1404
703 836 6620